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A CHECKLIST OF HORSE FLIES AND DEER FLIES (DIPTERA: TABANIDAE) OF CEDAR BOG, CHAMPAIGN COUNTY, OHIO[1]

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ABSTRACT. Intensive collecting in Cedar Bog, Champaign County, Ohio, during 1978 and 1979 utilizing a modified Malaise trap baited with dry-ice and shiny black sphere, and an aerial net, together with a review of specimens housed in 5 of Ohio's maintained insect collections, produced records for 33 species of horse flies and deer flies (Diptera: Tabanidae). The seasonal abundance for many of these species was documented by employing standardized collection techniques, and the great diversity of tabanid species was attributed to the wide variety of larval breeding habitats found in this area. Species unique to the bog, and some natural enemies of Tabanidae found there are discussed.

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INTRODUCTION

Cedar Bog is the only alkaline bog remaining in Ohio. Located in Champaign County, 3 miles south of Urbana, it has received much attention from botanists, zoologists, and geologists during the past 8 decades. Scientific investigations have delineated this swamp as a unique area harboring many isolated populations of plants and animals. The bog's hydrologic conditions produce a microclimate characteristic of northern bogs, essential for the continued survival of the unusual fauna present (Forsyth 1974, Frederick 1974).

One group of animals preserved by the wet conditions at Cedar Bog is the horse fly and deer fly family, the Tabanidae (Diptera). Immature stages of these insects are mostly aquatic or semi-aquatic predatory larvae that thrive in various saturated and semi-saturated substrates (Teskey 1969). Slow moving streams, drainage ditches, farm ponds, and swampy areas together with a variety of soil types including loams, mucks, peats and marly soils in and around the bog (Boker and Thomas 1974) provide breeding sites for a great diversity of Tabanidae. Biting female flies make their annoying presence known to visitors and workers in the area from early May until September.

As early as 1926, Hine (1903) collected Tabanidae at Cedar Bog and deposited specimens in the Ohio State University Reference Collection. Many other predominent dipterists and general entomologists have since collected in this area, and today their specimens are located in many of Ohio's curated insect collections. The majority of the early collection records are of deer fly (*Chrysops*) species. Members of this genus are easily obtained by collectors because they are highly attracted to man. The collection of horse flies of the genera *Tabanus, Atylotus, Hybomitra* and *Haematopota* requires special collection equipment because many members of these groups do not usually attack man, although they are often serious pests of livestock. Recent design modifications of the Malaise trap, and the use of chemical and visual attractants have resulted in traps very effective for collecting female tabanids (Wilson et al. 1966, Snoddy 1970).

The purpose of this paper is to summarize the historical records of Tabanidae collected at Cedar Bog, and to supplement

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this information with intensive weekly trapping and collection data, in order to document the seasonal distribution and abundance of the species present. Several natural enemies of Tabanidae were also collected and are reported.

METHODS AND MATERIALS

On 26 June 1978 and on a regular basis during 1979 (11, 18, 25 June; 2, 11, 16, 23, 30 July; 6, 13, 27 August; and 23 September) collections of Tabanidae were made using 2 collection techniques: A modified Malaise trap (2.4–4.5 m) baited with and a 35.6 cm diameter black sphere, and a 38 cm aerial insect net. The modified Malaise trap employs dry ice and a 35.6 cm diameter black sphere, and a 38 cm aerial insect net. The modified Malaise trap employs dry ice to produce carbon dioxide fumes. The flies are attracted to carbon dioxide because this gas is exhaled by their warm- and cold-blooded hosts. A large, black, shiny sphere suspended from the trap serves as a visual attractant. A similar "Malaise-type flight trap" was used by Woodruff in Cedar Bog first in 1968 (Philip et al. 1973).

During each visit to the bog, collections were made from approximately 11:00 am to 5:00 pm. During the June dates, the Malaise trap was erected on the boardwalk in the marl meadow association of sector D-7 (Frederick 1974). On 16 July, the trap was set up in the bog meadow association in sector F-10, and throughout the remainder of the collection visits it was erected on the boardwalk in the marl meadow association, sector E-5. These changes in trap location may have influenced the seasonal abundance results of tabanid species other than *Chrysops*. Deer flies were primarily collected with the aerial net while walking in the Cedar Bog area, especially around the boardwalk.

Tabanid eggs were collected from vegetation overhanging water and held in plastic bags until larvae hatched. Soon afterwards, the bags were inspected for the presence of small hymenopterous parasites which had emerged from the egg masses. Specimens were identified by P. M. Marsh (USDA Systematic Laboratory, Beltsville, MD) and C. Yoshimoto (Biosystematics Research Institute, Ottawa, Canada). The spider collected in association with a tabanid prey was determined by M. J. Walsh, Ohio State University, Columbus, OH.

RESULTS

The collection dates, the collectors, and the present specimen locations of Tabanidae from Cedar Bog are as follows:

Chrysops beameri Brennan 9 Aug. 1933 (FS, JT, & JH) (OSU); 20 July 1939 (CLW) (OSU); 2 Aug. 1951 (EST & CAT) (OSU); 5 Aug. 1969 (RLB & MAP) (ODH); 1 Sept. 1972 (RLB & MAP) (ODH); 23, 30 July, 6, 13, 27 Aug., 5 Sept. 1979 (BMD) (BMD).

Chrysops callidus Osten Sacken 5 June 1959 (DJK) (OSU); 26 June 1978 (BMD) (OHS); 25 June, 2, 11, 16, 23, 30 July 1979 (BMD) (BMD).

Chrysops cincticornis Walker 7 July 1927 (JSH) (OSU); 26 June 1978 (BMD) (OHS); 11, 18, 25 June 1979 (BMD) (BMD).

Chrysops cuclux Whitney 13 May 1965 (FJM) (OSU).

Chrysops flavidus Wiedemann 18, 25 June 1979 (BMD) (BMD).

Chrysops geminatus Wiedemann 24 July 1934 (OSU); 30 June 1946 (EST) (OSU); 26 June 1978 (BMD) (OHS); 25 June, 2, 11, 16, 23 July 1979 (BMD) (BMD).

Chrysops impunctus Krober 26 June 1978 (BMS) (OHS); 2, 11, 16, 23, 30 July, 6 Aug. 1979 (BMD) (BMD).

Chrysops indus Osten Sacken 5 June 1946 (EST) (OSU); 18 June 1979 (BMD) (BMD).

Chrysops macquarti Philip 7 June 1927 (JSH) (OSU); 10, 23 July 1964 (JFM) (OSU); 1 Sept., 1972 (MW) (ODH); 26 June 1978 (BMD) (OHS); 11, 18, 25 June, 2, 11, 16, 23, 30 July, 6, 13 Aug. 1979 (BMD) (BMD).

Chrysops moechus Osten Sacken 26 June 1978 (BMD) (OHS).

Chrysops niger Macquart 12 June 1926 (JSH) (OSU); 21 May 1964 (BF) (KSU); 13 May 1965 (FJM) (OSU); 14 May 1965 (JLW) (OSU); 5 June 1974 (GAC) (DM); 25 June 1979 (BMD) (BMD).

Chrysops sackeni Hine 12 June 1926 (JSH) (OSU).

Chrysops univittatus Macquart 2 Aug. 1951 (CAT) (OSU); 24 July 1954 (DJB) (OSU); 10, 23 July, 4, 17 Aug. 1964 (JLW) (OSU); 1 Sept. 1972 (RLB & MW) (ODH); 26 June 1978 (BMD) (OHS); 1 June, 11, 16, 23, 30 July, 6, 13, 27 Aug., 1979 (BMD) (BMD).

Chrysops vittatus Wiedemann 18 July 1933 (CFW) (OSU); 27 July 1935 (EST) (OSU); 20 July 1939 (CLW) (OSU); 2 Aug. 1951 (CAT) (OSU); 5 Aug. 1969 (RLB) (ODH); 26 June 1978 (BMD) (OHS); 18, 25 June, 2, 11, 16, 23, 30 July, 6, 13, 27 Aug. 1979 (BMD) (BMD).

Haematopota rara Johnson 10 June 1964 (JLW) (KSU); 26 June, 5 July 1968 (REW) (Philip et al. 1973); 29 June 1969 (REW) (OSU); 26 June 1978 (BMD) (BMD); 18 June, 2 July 1978 (BMD) (BMD).

Atylotus bicolor (Wiedemann) 1 Aug. (DJK) (OSU); 4 Aug. 1964 (DJB)(OSU); 26 June 1978 (BMD)(OHS); 25 June, 16, 30 July, 6 Aug. 1979 (BMD)(BMD).

Atylotus ohioensis (Hine) 20 July 1939 (CLW)(OSU); 25 June, 11, 16, 23, 30 July 1979 (BMD) (BMD).

Hybomitra lasoiphthalma (Macquart) 26 June 1978 (BMD)(OHS); 11, 16, 25 June, 2, 11 July 1979 (BMD)(BMD).

Hybomitra sodalis (Williston) 26 June 1978 (BMD)(BMD); 25 June, 11 July 1979 (BMD) (BMD).

Tabanus atratus atratus Fabricius 13 Aug. 1979 (BMD)(BMD).

Tabanus lineola Fabricius 11 July 1979 (BMD) (BMD).

Tabanus nigrescens Palisot de Beauvois 16 July, 6 Aug. 1979 (BMD)(BMD).

Tabanus nigripes Wiedemann 10 July 1964 (FJM) (OSU); 26 June 1978 (BMD) (OHS); 25 June, 2, 11, 16, 23, 30 July, 6, 13 Aug. 1979 (BMD)(BMD).

Tabanus pumilus Macquart 26 June 1978 (BMD) (OHS); 25 June, 2, 11, 16, 23, 30 July 1979 (BMD)(BMD).

Tabanus quinquevittatus Wiedemann 26 June 1978 (BMD)(OHS); 2, 11, 16, 23, 30 July, 6 Aug. 1979 (BMD)(BMD).

Tabanus reinwardtii Wiedemann 30 July 1979 (BMD)(BMD).

Tabanus sackeni Fairchild 17 Aug 1964 (JLW) (OSU); 5 Aug 1969 (RLB)(ODH); 23 July, 6, 13, 27 Aug. 1979 (BMD)(BMD).

Tabanus sparus milleri Whitney 21 June 1958 (EST)(OSU); 26 June 1978 (BMD)(OHS); 18 June, 2, 11, 16, 23, 30 July 1979 (BMD)(BMD).

Tabanus similis Macquart 26 June 1978 (BMD) (BMD); 25 June, 2, 11, 16, 30 July, 6, 13, Aug. 1979 (BMD)(BMD).

Tabanus sulcifrons Macquart 4 Aug. 1964 (JLW) (OSU); 23, 30 July, 6, 13 Aug. 1979 (BMD)(BMD).

Tabanus superjumentarius Whitney 26 June 1978 (BMD)(OHS); 18, 25 June, 11, 23 July, 13 Aug. 1979 (BMD)(BMD).

Tabanus trimaculata Palisot de Beauvois 26 June 1978 (BMD)(OHS); 2, 11, 16, 23, 30 July 1979 (BMD)(BMD).

The collectors' names are abbreviated as follows: RLB — R. L. Berry; DJB — D. J. Borror; GAC — G. A. Coovert; BMD — B. M. Drees; BF — Benjamin Foote; JH — James Hambleton; JSH — J. S. Hine; DJK — D. J. & J. N. Knull; FJM — F. J. Moore; MAP — M. A. Parsons; FS — Frank Semans; JT — John Thomas; EST — E. S. Thomas; CAT — C. A. Triplehorn; CFW — C. F. Walker; CLW — C. L. Ward; MW — M. Watkins; JLW — J. L. Williams; REW — R. E. Woodruff.

The institutions and collections housing the specimens are abbreviated as follows: OSU — Ohio State University; ODH — Ohio Department of Health; OHS — Ohio Historical Society; KSU — Kent State University; DM — Dayton Museum; BMD — B. M. Drees.

These records have been compiled by L. L. Pechuman of Cornell University and R. L. Berry of the Vector-Borne Disease Unit, Ohio Department of Health. Recent collection data by the author have also been incorporated. Collection records other than those of the author appear as open circles in figures 1 and 2.

Because of the difference in response shown by *Chrysops* as opposed to the other genera to the 2 collecting techniques, seasonal abundance results for the 2 groups are depicted in separate figures. The seasonal abundance data are summarized for the 1978 and 1979 collection results in figures 1 and 2. Species are listed in the order of their earliest collection records. These figures clearly indicate the predominant species at any given time during the season, and total seasonal abundance for each species. Unfortunately, the abundance data for the early season species are not available. Nevertheless, from the available data the predominant deer flies in the bog were *C. vittatus* and *C. beameri,* followed by *C. geminatus* and *C. macquarti.* For the remaining genera, *Tabanus nigripes* was the most abundant, followed by *Hybomitra lasiophthalma, T. pumilus,* and *T. sparus milleri.*

Two species of hymenopterous parasites were reared from tabanid egg masses collected in the bog. The wasp larvae parasitize the developing tabanid embryos. Adult *Telenomus tabanivorus* (Ashm.) emerged from egg masses of *Tabanus* or *Hybomitra* (probably *Hybomitra lasiophthalma*) collected from cattails on 25 June and 11 July 1979. *Trichogramma minutum* Riley emerged from *Chrysops* eggs collected on 30 July. One specimen of *Tabanus sackeni* was collected on 13 August from the web of a spider, *Micrathena gracilis* (Walckenaer).

DISCUSSION

Hine (1903) published the most complete account of Ohio Tabanidae. Although no specific mention was made of Cedar Bog, Hine listed 40 Ohio species. Seventeen of the scientific names he used were later revised or synonymized, and

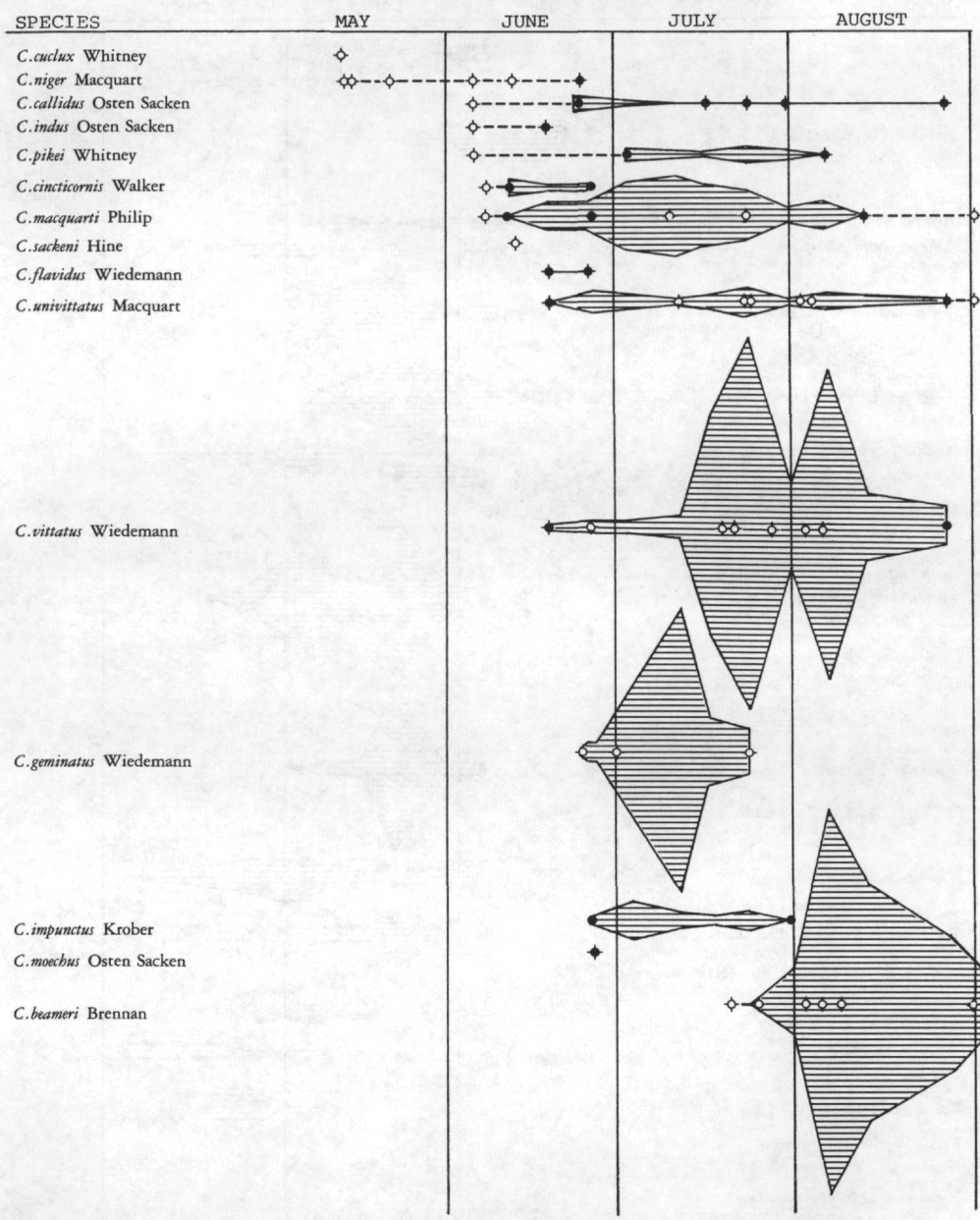

FIGURE 1. Seasonal abundance of deer flies (*Chrysops*) in Cedar Bog, Ohio. Each horizontal line designates approximately 2 specimens, and the open circles represent collection dates other than those of the author.

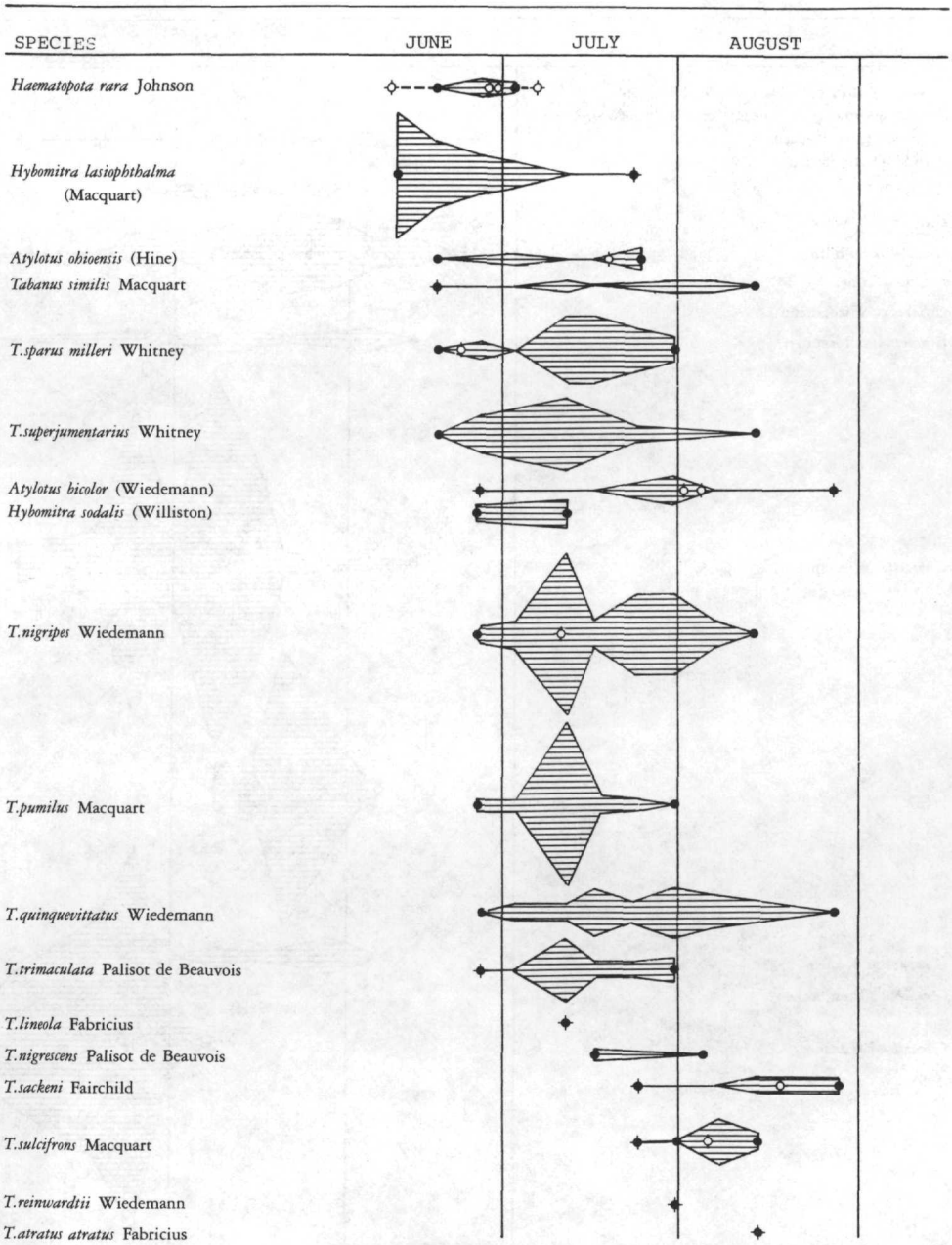

FIGURE 2. Seasonal abundance of horse flies (*Tabanus, Haematopota, Atylotus,* and *Hybomitra*) in Cedar Bog, Ohio. Each horizontal line designates one specimen, and the open circles represent collection dates other than those of the author.

several new species have since been described. Twenty-two of the species listed by Hine have now been reported from Cedar Bog. To date, L. L. Pechuman has confirmed records of 68 species of Tabanidae from Ohio, and the current study has documented the occurrence of 33 of these species in the bog. These data illustrate the great diversity of the tabanid fauna in this area.

Two of the bog's 33 tabanids are not known to occur anywhere else in Ohio. *Haematopota rara* is considered to be a "rare" species with obscure nonaggressive habits. Philip et al. (1973) believed this to be a northern species with a preference for bog habitats. Cedar Bog specimens represent the known western range limit for this species. Immature stages have not been reported. The 2nd unique tabanid in the bog is *Tabanus nigripes,* the most abundant horse fly in the area. Teskey (1969) mentions that the immatures of this species are common to habitats with acidic soil conditions such as sphagnum bogs or boglike backwaters of streams having a layer of moss and peat over sand. Although Cedar Bog is an alkaline bog, muck soils and peaty areas are present. Surprisingly, this species has not been collected in other areas of Ohio where suitable habitats exist. A 3rd species, *Chrysops beameri,* deserves comment. This deer fly has never been found to be abundant. The majority of the records for this species are from Virginia, and a few specimens have been collected in Maryland, West Virginia, and eastern Pennsylvania. Specimens have been taken in only 2 western Indiana counties; in Ohio it was previously known from Cedar Bog and from one specimen collected by D. J. Horn in Hocking County, 16 July 1977. Specimens collected in Cedar Bog in 1979 (305 females and 1 male) represent the longest series ever collected (L. L. Pechuman, Cornell Univ., Ithaca, N. Y., pers. comm.). Nothing is known of their biology or developmental stages.

The great diversity of tabanid species in Cedar Bog poses an interesting question: How can so many different species coexist in such a relatively small area? The answer to this question rests primarily upon species isolation mechanisms. The seasonal abundance data presented here suggest that several species are seasonally isolated, although overlapping does occur. Adult and larval behavioral idiosyncrasies constitute a wide variety of possible isolation mechanisms. One example is female preference for oviposition sites as associated with larval preference for particular habitats. Teskey (1969) reported that the majority of *Chrysops geminatus* larvae were found in "luxuriant moss growing in spring-fed drainage beds." On the other hand, the immatures of many species show little habitat preference; larvae of *Chrysops indus, C. univittatus, C. cincticornis, C. vittatus, C. callidus, C. niger,* and *Tabanus reinwardtii* are often found in "associations" (Teskey 1969). There is also a likelihood that not all of the species collected in the bog breed in the area. Tabanidae are known for their long flight range.

In Cedar Bog, observations were made supporting habitat preferences for certain species. As mentioned, *Chrysops* adults were collected with an aerial net while walking repeatedly around the boardwalk and along Woodburn Road, which transverses the bog. During these collection excursions, some species were found to be particularly abundant in certain areas, especially during the earlier portions of their seasonal occurrence. This early seasonal abundance of adults could well reflect habitat preferences of the immature stages of these species. *Chrysops geminatus,* for example, was the dominant species in Frederick's (1974) sectors F-5 and E-5; the *C. flavidus* specimens were both collected in sector D-6; *C. macquarti* was very common in D-8 and 9 along the margins of the marl meadow association of D-6 and E-5. Other species, including *C. vittatus* and *C. univittatus*, were generally distributed throughout the bog. Similar observations were not possible for species other than *Chrysops* because of the limited number of

trapping sites, but they do suggest that the wide variety of substrates and aquatic conditions in the Cedar Bog area provide suitable habitats for an unusually great diversity of Tabanidae.

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